REMARKS

Claims 18 and 20 are cancelled, claims 1, 13-17, 19, 21, 32, 39, and 44 are amended, and claims 47 and 48 are added herein. Claims 1-17, 19, and 21-48 will be pending upon entry of this amendment.

Claims 14-16 and 19 have been amended solely to improve the form of the claims. Specifically, these claims have been amended to recite the same preamble as the claim from which they depend.

The following remarks are responsive to the final Office action mailed July 11, 2006.

Response to Claim Rejections

Claims 1-12

Amended claim 1 is directed to a crystal puller for growing monocrystalline ingots according to the Czochralski method. The puller comprises:

a housing;

a crucible in the housing for containing a semiconductor source material melt, the melt having an upper surface;

a side heater adjacent the crucible for heating the crucible;

an elongate puller having an end adapted to connect to the ingot for pulling a growing ingot upward from the upper surface of the melt, a portion of the upper surface of the melt remaining exposed during growing of the ingot, the exposed upper surface portion having an area; and

an annular melt heat exchanger sized and shaped for surrounding the ingot and for being disposed adjacent the exposed upper surface portion of the melt, the heat exchanger including a heat source disposed to face the exposed upper

surface portion of the melt, the heat source having an area for radiating heat to the melt sized at least 30% of the area of the exposed upper surface portion of the melt for controlling heat transfer at the upper surface of the melt, the melt heat exchanger being adapted to reduce heat loss at the exposed upper surface portion, **the exposed upper surface portion of the melt allowing gases produced in the melt during heating thereof to exit the melt.**

Amended claim 1 is nonobvious and patentable over the references of record, including JP Patent Application No. SHO 63-8291 (Ueya).

As shown in Fig. 1, Ueya discloses a semiconductor manufacturing apparatus having a gas tight vessel (41) and a melt tank (42) located in the vessel. An electric heater (52) is positioned inside the wall (43) of the melt tank (42) for melting a semiconductor base material to form a melt (51), and a liquid surface heating apparatus (60) is provided for maintaining the temperature of the upper layer of the melt (51). A cover liquid (53), such as a low-melting-point glass liquid or the like, covers the melt (51) for preventing "gasification" thereof. See page 4, second paragraph, last sentence of the translation of the Ueya reference. In other words, Ueya teaches that melt off-gases should be inhibited.

As a result of the cover liquid, the melt of Ueya does not have a portion of its upper surface exposed during growing of the ingot. Instead, Ueya discloses that the melt is covered by a liquid to prevent "gasification". No portion of the upper surface of the melt of Ueya is exposed. The cover liquid increases the dissolved gas concentration in the melt by reducing the surface area available for transport and traps

gases (e.g., oxygen) in the melt, rather than allowing the gases to leave the melt. The gases, such as oxygen, remain in the system in high concentration where they can negatively impact the resulting ingot. See, for example, pages 3-5 of applicant's specification which discusses oxygen precipitation.

Applicant's claimed puller, on the other hand, recites that a portion of the upper surface of the melt remains exposed while the ingot is being grown to allow gases produced in the melt during heating thereof to exit the melt. As a result, gases, such as oxygen, exit the melt and thereby prevent the gases from being trapped in the melt and negatively impacting the quality of the ingot.

Ueya fails to teach or suggest a crystal puller having a portion of the upper surface of the melt remaining exposed during growing of the ingot that allows gases produced in the melt during heating thereof to exit the melt as recited in amended claim 1.

Thus, amended claim 1 is nonobvious and patentable over Ueya. Claims 2-12 depend from amended claim 1 and are patentable over Ueya for at least the same reasons as claim 1.

Claims 8 and 10-12

Claim 8 depends indirectly from claim 1 and further recites that a reflector includes insulation interposed between the melt heat exchanger and the melt. Claim 10, which depends indirectly from claims 1 and 8, recites that the crystal puller further comprises a lower crystal heater disposed above the crystal heat exchanger and adapted for substantially surrounding the ingot for maintaining a second segment of the ingot at a predetermined temperature. Claim 11 depends from claim 10 and recites that the crystal heat exchanger and the

lower crystal heater are mounted in the reflector, the reflector further comprising insulation disposed between the crystal heat exchanger and the ingot and between the lower crystal heater and the housing. Claim 12, which also depends from claim 10, recites an upper crystal heater disposed above the lower crystal heater and substantially surrounding the ingot for maintaining a third segment of the ingot at a predetermined temperature.

While each of these claims stands rejected as being obvious in view of Ueya in combination with U.S. Patent No. 6,117,402 (Kotooka et al.) and JP 11-255,577 (JP '577), nowhere in the Office action does the Office even mention the terms/phrases "insulation", "lower crystal heater", "upper crystal heater", or equivalents thereof. As a result, the Office has clearly failed to establish a *prima facie* case with respect to claims 8 and 10-12. Accordingly, the Office's rejection of these claims cannot be sustained as presented in the Office action.

Claims 21-31

Amended claim 21 is directed to a method of growing a monocrystalline ingot comprising:

forming a melt of semiconductor source material in a crucible, the melt having a surface;

positioning a heat source to face the exposed upper surface portion of the melt, the heat source having an area for radiating heat to the melt sized at least 30% of the area of the exposed upper surface portion of the melt;

pulling semiconductor source material from the surface of the melt such that the source material solidifies into a monocrystalline ingot;

selectively controlling heat transfer at the surface of the melt using the heat source; and

allowing gases produced in the melt during heating thereof to exit the melt via the exposed upper surface of the melt.

To the extent amended claim 21 recites the same features as amended claim 1, claim 21 is nonobvious and patentable over Ueya for the same reasons as set forth above with respect to claim 1. More specifically, claim 21 is directed to a method of growing a monocrystalline ingot comprising, in part, positioning a heat source to face the exposed upper surface portion of the melt and allowing gases produced in the melt during heating thereof to exit the melt via the exposed upper surface of the melt. As mentioned in detail above, Ueya expressly teaches inhibiting gases produced in the melt during heating of the melt to escape the melt. Accordingly, claim 21 is patentable over Ueya.

Claims 22-31 depend from amended claim 21 and are patentable over Ueya for at least the same reasons as claim 21.

Claims 24-31

Claims 24-31 stand rejected as being obvious in view of Ueya in combination with Kotooka et al. and JP '577. However, nowhere in the Office action does the Office assert that the features recited in these claims are taught or suggested by any one of the cited references. As a result, the Office has clearly failed to establish a *prima facie* case with respect to claims 24-31, and the Office's rejection of claims 24-31 cannot be sustained as presented in the Office action.

Claim 17

Amended claim 17 is directed to a reflector for use in a crystal puller for growing a monocrystalline ingot from a semiconductor source material melt. The crystal puller has a housing, a crucible contained in the housing for holding the source material melt, a heater in thermal communication with the crucible for heating the crucible to a temperature sufficient to melt the semiconductor source material held by the crucible, and a puller positioned above the crucible for pulling the ingot from the melt. The reflector is disposed above the melt and has a central opening sized and shaped for surrounding the ingot as the ingot is pulled from the melt. The reflector comprising:

a crystal heat exchanger sized and shaped for placement above the melt and substantially surrounding the ingot for cooling a first segment of the growing ingot proximate a melt/crystal interface, and

a lower crystal heater disposed above the crystal heat exchanger and substantially surrounding the ingot for maintaining a second segment of the ingot at a predetermined temperature.

Amended claim 17 is nonobvious and patentable over the references of record, including Ueya in view of Kotooka et al. and JP '577, because the references fail to show or suggest a reflector including a crystal heat exchanger for cooling a first segment of the growing ingot proximate a melt/crystal interface and a lower crystal heater disposed above the crystal

heat exchanger for maintaining a second segment of the ingot at a predetermined temperature.

Nowhere in the Office action does the Office assert that any of the cited references disclose a crystal heat exchanger and a crystal heater spaced above the crystal heat exchanger. Indeed, each of the cited references fails to teach or suggest a reflector including a lower crystal heater disposed above the crystal heat exchanger and substantially surrounding the ingot for maintaining a second segment of the ingot at a predetermined temperature as recited in amended claim 17. Accordingly, the Office has failed to establish a *prima facie* case of obviousness with respect to claim 17.

As a result, amended claim 17 is nonobvious in view of and patentable over Ueya in view of Kotooka et al. and JP '577.

Claim 19

Claim 19 depends from claim 17 and recites that the reflector further comprises an upper crystal heater disposed above the lower crystal heater and substantially surrounding the ingot for maintaining a third segment of the ingot at a predetermined temperature. Nowhere does the Office assert that any of the cited references disclose or suggest an "upper crystal heater" as recited in claim 19. Indeed, none of the cited references show or suggest an upper crystal heater as recited in claim 19.

Accordingly, claim 19 is further patentable over Ueya in view of Kotooka et al. and JP '577.

Claims 32-38

Amended claim 32 is directed to a method of growing a monocrystalline ingot using a crystal puller including a

housing, a crucible in the housing for containing a semiconductor source material melt having a surface, a side heater adjacent the crucible for heating the crucible, and a melt heat exchanger facing at least 30% of an exposed portion of the melt surface for heating the exposed portion, the method comprising:

pulling the growing ingot upward from the melt, a melt/ingot interface being formed generally at a juncture of the ingot and the melt surface,

simultaneously operating the side heater and the melt heat exchanger, and

controlling the temperatures of the melt heat exchanger and the side heater to control formation of defects within the ingot.

The applicants point out that the Office has failed to establish a *prima facie* case with respect to its rejection of claim 32. Nowhere in the Office action does the Office assert that any one of the cited references teach or suggest the method steps recited in claim 32. Accordingly, the Office's rejection of claim 32 cannot be sustained.

Moreover, amended claim 32 is nonobvious and patentable over the references of record, including Ueya in view of Kotooka et al. and JP '577, because the references fail to show or suggest a method of growing a monocrystalline ingot including simultaneously operating the side heater and the melt heat exchanger.

In Ueya, the crucible heater 52 and the heating apparatus 60 are not operated at the same time. Instead, the crucible heater 52 is used to heat the melt tank 42 and melt the melt 51. Once the melt is melted, the crucible heater 52 is turned

off and then the heating apparatus 60 is started to maintain the upper layer of the melt 51 at a specified temperature. See page 5, last paragraph of the translation. Accordingly, Ueya does not teach or suggest simultaneously operating a side heater and a melt heat exchanger as recited in amended claim 32.

Kotooka et al. and JP '577 are apparently not relied on by the Office as teaching the claimed side heater and melt heat exchanger.

Accordingly, amended claim 32 is submitted to be patentable over the combination of Ueya, Kotooka et al., and JP '577.

Claims 33-38 depend from amended claim 32 and are patentable over Ueya in view of Kotooka et al. and JP '577 for at least the same reasons.

Claims 33-38

Claims 33-38 stand rejected as being obvious in view of Ueya in combination with Kotooka et al. and JP '577. However, nowhere in the Office action does the Office assert that the features recited in these claims are taught or suggest by any one of the cited references. As a result, the Office has clearly failed to establish a *prima facie* case with respect to claims 33-38, and the Office's rejection of claims 33-38 cannot be sustained as presented in the Office action.

Claim 39

Amended claim 39 is directed to a method of growing a monocrystalline ingot using a crystal puller including a housing. A crucible is in the housing for containing a semiconductor source material melt having an upper surface. A side heater is adjacent the crucible for heating the crucible. A pulling mechanism is for pulling a growing ingot upward from the melt. A melt/crystal interface is formed generally at the upper surface of the melt and has a shape. An annular melt heat exchanger includes a heat source having an area for radiating heat to the melt sized at least 30% of the area of an exposed upper surface portion of the melt. A crystal heat exchanger surrounds the ingot and faces the ingot for removing heat from the ingot adjacent the melt/crystal interface. The method comprises:

pulling the growing ingot upward from the melt; and

controlling an axial temperature gradient at the interface by manipulating a temperature field at the melt/ingot interface; and

allowing gases produced in the melt during heating thereof to exit the melt via the exposed upper surface of the melt.

To the extent amended claim 39 recites the same features as amended claim 21, claim 39 is patentable over Ueya in view of Kotooka et al. and JP '577 for the same reasons. Claims 40-43 depend from amended claim 39 and are patentable over Ueya in view of Kotooka et al. and JP '577 for at least the same reasons as amended claim 39.

Claims 40-43

Claims 40-43 stand rejected as being obvious in view of Ueya in combination with Kotooka et al. and JP '577. However, nowhere in the Office action does the Office assert that the features recited in these claims are taught or suggested by any one of the cited references. As a result, the Office has clearly failed to establish a *prima facie* case with respect to claims 40-43, and the Office's rejection of claims 40-43 cannot be sustained as presented in the Office action.

Claims 44

Amended claim 44 is directed to a method of growing a monocrystalline ingot using a crystal puller including a housing, a crucible in the housing for containing a semiconductor source material melt having a surface, a side heater adjacent the crucible for heating the crucible, and a melt heat exchanger surrounding the ingot and facing an exposed portion of the melt surface. The melt heat exchanger includes a heat source having an area for radiating heat to the melt sized at least 30% of the area of an exposed upper surface portion of the melt for heating the exposed portion. A lower heater is for surrounding the growing ingot. The method comprises:

pulling the growing ingot upward from the melt, a melt/ingot interface being formed generally at a juncture of the ingot and the melt surface,

simultaneously operating the side heater, melt heat exchanger, and lower heater;

controlling heat radiated from the melt heat exchanger and the side heater to control the interface shape; and

controlling heat radiated from the lower heater to control the thermal history of segments of the growing ingot.

To the extent amended claim 44 recites the same features as amended claim 32, claim 44 is patentable over Ueya in view of Kotooka et al. and JP '577 for the same reasons as set forth above with respect to claim 32. Claims 45 and 46 depend from amended claim 44 and are patentable over Ueya in view of Kotooka et al. and JP '577 for at least the same reasons as amended claim 39.

Claims 45 and 46

Claims 45 and 46 stand rejected as being obvious in view of Ueya in combination with Kotooka et al. and JP '577. However, nowhere in the Office action does the Office assert that the features recited in these claims are taught or suggested by any one of the cited references. As a result, the Office has clearly failed to establish a *prima facie* case with respect to claims 45 and 46, and the Office's rejection of claims 45 and 46 cannot be sustained as presented in the Office action.

New claim 47

Added claim 47 is directed to a crystal puller for growing monocrystalline ingots according to the Czochralski method. The puller comprises:

a housing;

a crucible in the housing for containing a semiconductor source material melt, the melt having an upper surface;

a side heater adjacent the crucible for heating the crucible;

an elongate puller having an end adapted to connect to the ingot for pulling a growing ingot upward from the upper surface of the melt, a portion of the upper surface of the melt remaining exposed during growing of the ingot;

a reflector disposed above the melt and having a central opening sized and shaped for surrounding the ingot as the ingot is pulled from the melt, the reflector including a melt heat exchanger at least partially inside the reflector adapted to surround the ingot proximate the surface of the melt for controlling heat transfer at the surface of the melt, the melt heat exchanger being adapted to reduce heat loss at the exposed surface, and a crystal heat exchanger at least partially inside the reflector and disposed above the melt heat exchanger, the crystal heat exchanger being adapted to substantially surround the ingot for cooling a first segment of the growing ingot that is adjacent the melt/crystal interface; and

an upper heater disposed above and outside the reflector.

Added claim 47 is submitted as patentable over the references of record including Ueya in combination with Kotooka et al. and JP '577. In particular, the cited prior art references fail to show or suggest an upper heater disposed above and outside the reflector. Accordingly, new claim 47 is submitted to be patentable over the references of record.

New Claim 48

Added claim 48 depends from claim 47 and recites that the crystal puller further comprises a lower heater disposed at least partially inside the reflector and above the crystal heat exchanger. Added claim 48 is submitted as patentable over the references of record including Ueya in combination with Kotooka

et al. and JP '577. In particular, the cited prior art references fail to show or suggest a lower heater disposed at least partially inside a reflector and above a crystal heat exchanger. Accordingly, new claim 48 is submitted to be patentable over the references of record.

CONCLUSION

In view of the above, applicants respectfully request favorable reconsideration and allowance of claims 1-17, 19, and 21-48.

The undersigned requests a telephone call from the Examiner if it would expedite allowance of the application.

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